

Prevalence Rates of Respiratory Symptoms in Italian General Population Samples Exposed to Different Levels of Air Pollution

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We surveyed two general population samples aged 8 to 64 living in the unpolluted, rural area of the Po Delta (northern Italy) ($n = 3289$) and in the urban area of Pisa (central Italy) ($n = 2917$). Each subject filled out a standardized interviewer-administered questionnaire. The Pisa sample was divided into three groups according to their residence in the urban-suburban areas and to outdoor air pollution exposure (automobile exhaust only or industrial fumes as well). Significantly higher prevalence rates of all the respiratory symptoms and diseases were found in Pisa compared with the Po Delta. In particular, rhinitis and wheezing symptoms were higher in all the three urban zones; chronic cough and phlegm were higher in the zone with the automobile exhaust and the additional industrial exposure. Current smoking was more frequent in the rural area, but the urban smokers had a higher lifetime cigarette consumption. Childhood respiratory trouble and recurrent respiratory illnesses were evenly distributed. Exposure to parental smoking in childhood and lower educational level were more frequent in Po Delta, whereas familial history of respiratory/allergic disorders and work and indoor exposures were more often reported in the city. Multiple logistic regression models estimating independently the role of the various risk factors showed significant odds ratios associated with residence in Pisa for all the symptoms but chronic phlegm. For example, those living in the urban-industrial zone had an odds ratio of 4.0 (4.3-3.7) for rhinitis and 2.8 (3.0-2.6) for wheeze with respect to those living in the Po Delta. In conclusion, these preliminary analyses indicate an urban factor related to the rates of respiratory symptoms and diseases in Italy in the 1980s.

Introduction

Epidemiological studies in general population samples have yielded strong evidence on the deleterious effects of cigarette smoking as a risk factor in the etiology of airway obstructive diseases (AOD) (1-3). The roles of other risk factors, both host and environmental (e.g., childhood respiratory trouble, familial history of respiratory illness, work exposure, involuntary cigarette smoking, indoor air pollution) have been recently reviewed (4).

Differences in prevalence rates of respiratory symptoms among subjects living in less polluted and more polluted areas, and the so called "urban factor," have been shown by several investigators in different countries (5-10), but not yet in Italy. We were able to perform two different general population surveys in

northern and central Italy: the Po Delta study and the Pisa study. Our longitudinal epidemiological survey in the Po River Delta area (20 km south of Venice) has been designed to study the natural history of AOD (3). It initially evaluated health status before the operation of a large oil-burning thermoelectric power plant in this unpolluted, rural area. Lung function tests and a standardized respiratory questionnaire were employed. In addition, we used the same questionnaire to investigate a general population sample of Pisa (central Italy), chosen based on exposure, mainly to automobile exhaust and some industrial pollutants. The aim of this paper is to report prevalence rates of respiratory symptoms, diseases, and risk factors in these two general population samples exposed to different levels of air pollution.

Materials and Methods

In the Po River Delta, the first cross-sectional study was performed in 1980 to 1982. The second survey on the same subjects is now going on, after the start-up of the power plant (June 1982). The eight levels of sulfur dioxide (SO_2) from automated, continuous monitoring stations in the area were negligible at the time of the first study (11); similarly, low values of integrated concentrations of total suspended particulates (TSP) were found ($30 \pm 15 \mu\text{g}/\text{m}^3$).

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Characteristics of the population sample, the Italian National Research Council (CNR) questionnaire (Italian version of the American Thoracic Society questionnaire), reference equations for the lung function tests and their relationships with symptoms, prevalence rates of respiratory symptoms and diseases, and effects of important risk factors (smoking, childhood respiratory trouble, familial history of respiratory diseases, work and indoor pollution exposures) have been previously described (3,11-21). Comparisons of questionnaires (12) and between questionnaires and lung function (3,15-21) indicate that questionnaire responses were appropriate and mutually and externally consistent.

Briefly, the population was sampled according to a multistage, stratified, cluster design. There were 3289 participants aged 8 to 64 years (78% of the expected subjects); they were not significantly different from the expected sample by socioeconomic condition (SES), nor from the nonparticipants by age and SES (11). Each subject completed an interviewer-administered questionnaire developed, as a modified CNR Italian version of the standard National Heart and Lung Institute questionnaire, by the CNR Special Project on Chronic Obstructive Lung Disease. The questionnaire contains 67 questions regarding respiratory symptoms, diseases, and risk factors.

The same CNR questionnaire was used to investigate the urban and suburban residents of Pisa in 1985 to 1988. Populations in three zones were consecutively studied, based on air pollution exposure: one in the southeast part of the city (Pisa-SE) and one in the suburbs (Cascina), mainly affected by automobile exhaust from the heavily used highway connecting Pisa to Florence (it passes through a densely polluted area closely surrounded by houses); another in the southwest part of the city (Pisa-SW) affected by both the heavily used highway connecting Pisa to Rome and fumes (high in SO₂ and TSP) deriving from industry. In Pisa-SE and in Cascina, integrated levels of SO₂ were low (16 ± 13 and $10 \pm 13 \mu\text{g}/\text{m}^3$), whereas mean annual concentrations of TSP in the three monitoring stations along the highway ranged between 64 ± 36 and $140 \pm 63 \mu\text{g}/\text{m}^3$ (a value very close to the National Air Quality Standard of $150 \mu\text{g}/\text{m}^3$). In Pisa-SW, high integrated values of both pollutants were recorded (TSP, $138 \pm 56 \mu\text{g}/\text{m}^3$; SO₂, $31 \pm 12 \mu\text{g}/\text{m}^3$, with daily 5-min peaks up to $1000 \mu\text{g}/\text{m}^3$). Use of a suburban area as well as urban areas helps determining the "urban" factor in relation to chronic symptoms. In this study, the population sample of 3866 (77% of expected subjects, age 5-90 years) was also a family-based, multistage stratified, cluster design. For the current analyses, only those subjects less than 64 years of age ($n = 2917$) were taken into account.

Nonsmokers (NS) were defined as those who had never smoked any kind of tobacco regularly. Smokers (5) were those who were currently smoking at least one cigarette daily. Ex-smokers (ES) included those who had formerly smoked regularly until 6 months or more before the examination.

The following symptoms were considered for the analysis a) chronic cough (or phlegm); coughing (or producing phlegm) for as much as 3 months of the year for at least 2 years; b) wheeze, apart from common colds; c) attacks of shortness of breath with wheeze (SOBWHZ), apart from common colds; d) dyspnea, shortness of breath when hurrying on level ground or walking up a slight hill (grade 1) or when walking on level ground with persons of the same age (grade 2+); e) rhinitis, hay fever, or any

other allergy making the nose runny or stuffy, apart from common colds. Emphysema, chronic bronchitis, asthma, tuberculosis, pleuritis, and abnormal chest X-ray (for lung involvement) were taken into account if the diagnosis was confirmed by a physician.

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) routines. Among the different zones studied, chi-square or Kendall's tau for trend were used to compare symptom prevalence rates, and analysis of variance was used to compare the mean values of continuous variables. In order to take into account the role of different risk factors in determining respiratory symptoms and diseases, we used a multiple logistic regression model, with sex (0 = female, 1 = male), age (0 = less than 40 years, 1 = more than 40 years), smoking habit (0 = nonsmoker, 1 = ever smoker), pack-years (0 = less than 20, 1 = more than 20). Also included were the presence or absence of such risk factors as familial history of respiratory or allergic disorders, work exposure, education (less or more than high school), indoor exposure (stove with cooking/heating fuel different from natural gas central heating with natural gas), and zone of residence (Pisa versus Po Delta). All the relationships are significant at $p < 0.05$, unless otherwise stated.

Results

The characteristics of the populations studied are described in Table 1. Subjects in the Po Delta were significantly younger than in Pisa, but the maximum difference was 4 years. In the Po Delta there were significantly more current smokers, but the ever smokers had a slightly lower lifetime cigarette consumption than in Pisa, where there were more ex-smokers.

With respect to respiratory symptoms (Table 2), the inhabitants of Pisa-SW showed the highest prevalence rates; those living in Pisa-SE and in Cascina had similar values to those in the Po Delta for cough and phlegm, but much higher rates for wheezing symptoms, dyspnea, and rhinitis.

A similar trend was seen for medical diagnoses of respiratory diseases (Table 3). The labels of chronic bronchitis and emphysema were hardly used by Po Delta family practitioners. All diagnoses, with the exception of tuberculosis, were more frequent in Pisa. The differences among the three Pisa zones were less striking than those related to respiratory symptoms.

Regarding the risk factors considered (Table 4), the prevalence rates of childhood respiratory trouble and recurrent respiratory infections were quite similar: the latter showed a significant increasing trend from Po Delta to Pisa-SW. A history of respiratory and of allergic disorders in the family was more frequently

Table 1. Characteristics of the study population, ages 8 to 64 years.

Characteristic	Po Delta	Cascina	Pisa-SE	Pisa-SW
<i>n</i>	3289	1697	685	679
Males, %	48	48	49	49
Age, years	34 ± 16	37 ± 16	38 ± 17	$39 \pm 17^*$
Ever smokers, %	49	47	45	51*
Current, %	40	30	29	30*
Ex, %	9	17	16	21
Pack-years, <i>n</i>	13 ± 15	16 ± 17	16 ± 16	$16 \pm 19^*$

* $p < 0.001$ (by chi square).

Table 2. Comparison of prevalence rates (%) of respiratory symptoms.

Symptom	Po Delta	Cascina	Pisa-SE	Pisa-SW
<i>n</i>	3289	1697	685	679
Chronic cough	9	10	11	17*
Chronic phlegm	9	9	7	14 [†]
Wheeze	8	15	17	23
SOBWHZ ^a	5	8	9	9*
Dyspnea	14	22	26	28*
Grade 1	11	19	21	22*
Grade 2+	3	3	5	6 [†]
Rhinitis	5	17	13	25*

^aSOBWHZ, attacks of wheezing dyspnea.**p* < 0.001.[†]*p* < 0.01.[‡]*p* < 0.05 (by chi square).**Table 3. Comparison of prevalence rates (%) of diagnoses of respiratory diseases.**

Disease	Po Delta	Cascina	Pisa-SE	Pisa-SW
<i>n</i>	3289	1697	685	679
Chronic bronchitis	2	4	6	5*
Emphysema	1	3	5	6*
COLD ^a	2	5	7	8*
Asthma	5	7	12	5*
Current	3	2	4	3
Previous	2	5	8	2*
TBC	4	3	3	3 [†]
Pleuritis	6	8	11	10*
Abnormal	5	8	6	11*

^aCOLD, diagnosis of emphysema or chronic bronchitis.**p* < 0.001.[†]*p* < 0.05 (by chi square).**Table 4. Comparison of prevalence rates (%) of risk factors for respiratory symptoms and diseases.**

Risk factor ^a	Po Delta	Cascina	Pisa-SE	Pisa-SW
<i>n</i>	3289	1697	685	679
RRI	11	12	14	14 [†]
CRT	11	13	13	13
Respiratory, familial	40	58	49	59*
Allergic, familial	19	44	33	45*
Work exposure	15	43	22	37*
Low education	85	81	78	74*
Indoor exposure	45	65	32	49*
Smoking parents	80	77	75	76*

^aRRI, recurrent respiratory infections; CRT, childhood respiratory trouble; Respiratory/allergic familial, familial history for respiratory/allergic disorders; work exposure, to specific dusts/chemicals/fumes; low education, less than high degree; indoor exposure, to stove and/or fuel other than natural gas.**p* < 0.001 (by chi square).[†]*p* < 0.05 (by Kendall's tau).

reported in the urban-suburban zones. The vast majority of subjects reported exposure to parental smoking in childhood and had not completed the high school degree. Work exposure to dusts or chemicals and fumes was infrequently reported, except in Cascina. The highest frequency of indoor pollution exposure was also reported in Cascina.

The results obtained using the multiple logistic regression models are shown in Table 5. Sex was significantly associated with the risk of chronic phlegm in males and dyspnea in females. An age over 40 years was significantly associated with higher risks for all symptoms except attacks of shortness of breath with wheeze; the highest odds ratio was found for dyspnea. Smoking

status and cigarette consumption were associated with all respiratory symptoms except rhinitis. A family history of respiratory disorders was related to higher odds ratios for cough, wheeze, dyspnea, rhinitis. A family history of allergic disorders was positively associated with wheezing symptoms and rhinitis and negatively associated with dyspnea. Work exposure to dusts or chemicals and fumes and a low level of education were confirmed as significant risk factors for all respiratory symptoms (with the exception of a negative association of a low level of education with rhinitis). The use of a stove and/or a fuel different from natural gas was significantly related only to chronic cough, SOBWHZ, and dyspnea. Finally, residence in the Pisa urban and suburban zones was significantly associated with all respiratory symptoms except chronic phlegm; the odds ratios for wheeze and rhinitis were the highest, especially in the urban-industrial zone. When multiple logistic models were repeated in nonsmokers only, odds ratios almost identical to those in the general population were found for residence in urban zones, e.g., the risk of having wheeze was 1.4 in Cascina, 1.9 in Pisa-SE, and 2.5 in Pisa-SW.

Discussion

These preliminary analyses indicate an urban factor in Italy during the 1980s. Further investigation will be devoted to better characterize the population sample and outdoor air pollution exposure, as well as to stratify subjects according to other risk factors, in order to provide additional support for this hypothesis. However, the suggestion of an adverse role of outdoor air pollution exposure in relation to symptoms of AOD is consistent with the findings of other authors (3–10). In fact, we found higher prevalence rates of respiratory symptoms and diseases in those living in the urban area, especially if they were exposed to additional air pollution from industry. Multiple logistic regression models, which estimate the independent effect of each risk factor, strengthened the role of urban residence as a risk factor. It is noteworthy that the highest odds ratios associated with zone of residence were those for wheeze and rhinitis, which showed consistently higher prevalence rates in all the Pisa zones. Thus, wheeze and rhinitis seem to be influenced by minor gradients of air pollution compared with cough or phlegm, which showed higher prevalence rates only in the urban-industrial zone of Pisa-SW. All these symptoms are included among the adverse health effects of air pollution, as stated in the American Thoracic Society guideline (22).

It is unlikely that these differences were affected by recall bias due to different awareness of health risks. Standard procedure followed by both nurse teams required questions on symptoms to be asked by the interviewer first and those related to risk factors last. In addition, subjects were selected randomly from community populations, and our previous report (11) has shown that participants in the Po Delta study were not different from the expected sample according to the census distribution. There is no reason to suspect different behavior since the modality of sampling of the Pisa sample, and the rate of participation were the same.

As regards migration, generally in northern-central Italy the population is quite stable. The longitudinal observation we are currently carrying out in the Po Delta indicates very little migration in that area. This issue will be investigated further regarding Pisa. A very preliminary comparison of the last available census

Table 5. Effects of risk factors for respiratory symptoms, odds ratio and confidence intervals.^a

Risk factor ^b	Cough	Phlegm	Wheeze	SOBWHZ ^c	Dyspnea	Rhinitis
Sex	—	1.4 (1.8–1.2)	—	—	0.4 (0.5–0.3)	—
Age	1.3 (1.6–1.1)	1.3 (1.6–1.0)	1.2 (1.4–1.0)	—	4.2 (4.9–3.6)	1.3 (1.6–1.1)
Ever smoking	3.5 (4.3–2.8)	3.8 (4.9–3.0)	2.0 (2.4–1.6)	—	1.5 (1.7–1.2)	—
Pack-years	2.7 (3.3–2.1)	2.5 (3.2–2.0)	2.5 (3.2–2.0)	1.5 (2.1–1.1)	1.9 (2.4–1.5)	—
Respiratory, familial	1.3 (1.6–1.1)	—	1.3 (1.6–1.1)	—	1.3 (1.5–1.2)	1.2 (1.4–1.0)
Allergic, familial	—	—	1.4 (1.6–1.1)	1.8 (2.2–1.4)	0.8 (0.9–0.7)	1.7 (2.1–1.5)
Work exposure	1.3 (1.6–1.1)	1.4 (1.6–1.1)	1.5 (1.8–1.3)	1.5 (1.9–1.2)	1.9 (2.3–1.6)	1.4 (1.7–1.2)
Low education	1.3 (1.6–1.0)	1.3 (1.6–1.0)	1.3 (1.6–1.0)	1.3 (1.6–1.0)	1.5 (1.9–1.2)	0.7 (0.8–0.6)
Indoor exposure	1.2 (1.4–1.0)	—	—	1.2 (1.5–1.0)	1.2 (1.4–1.1)	—
Zone						
Cascina	1.2 (1.3–1.1)	—	1.4 (1.5–1.3)	1.2 (1.3–1.1)	1.3 (1.4–1.2)	1.6 (1.7–1.5)
Pisa-SE	1.4 (1.5–1.3)	—	2.0 (2.1–1.8)	1.4 (1.5–1.3)	1.6 (1.8–1.5)	2.5 (2.7–2.3)
Pisa-SW	1.7 (1.8–1.6)	—	2.8 (3.0–2.6)	1.6 (1.8–1.5)	2.1 (2.2–1.9)	4.0 (4.3–3.7)

^aDerived from multiple logistic models, compared to subjects without the risk factors.

^bAge, > 40 years; pack-years, > 20; respiratory/allergic, familial, familial history for respiratory/allergic disorders; work exposure, to specific dusts/chemicals/fumes; low education, less than high school degree; indoor exposure, to stove and/or fuel other than natural gas.

^cSOBWHZ, attacks of wheezing dyspnea.

(1981) and the civic records (1987) indicates that there had been an emigration of some people (near 500) from Pisa-SW toward new residential area in the northeast part of the city (not included in the study). This phenomenon could have produced more conservative results if the reason for moving were the presence of air pollution in Pisa-SW.

The possibility of a reporting bias due to odor, observation, or newspaper stories, cannot be completely excluded, but it could only apply to the industrial zone of Pisa-SW, since the risk due to automobile exhaust in the other zones was not as visible nor well known by the population. The use of more objective tools, such as lung function and bronchial responsiveness measurements, should help in addressing this issue in the planned follow-up survey. However, it is of note that the presence of a biologic effect of air pollution on respiratory symptoms with fewer physiological changes has been proposed by Dales et al. (23), who found a relationship between the residence downwind from natural gas refineries and symptoms, but not lung function.

Furthermore, it is unlikely that the differences we found among Po Delta and Pisa residents are due to different weight of risk factors in the two populations. In fact, the difference in age was quite small, and, although Pisa smokers had a slightly higher cigarette consumption, in Po Delta there was a higher proportion of current smokers. This reflects the national trend of decreasing current smoking in the cities (24). In addition, the prevalence rates of important host factors, such as recurrent respiratory infections and childhood respiratory trouble (19), were low in both studies. More than three-fourths of subjects reported either an exposure to passive smoking in their childhood or a low level of education; thus, the effect of these risk factors (indeed more frequent in Po Delta) should be diluted among the whole sample. The urban residents reported a familial history of respiratory or allergic diseases more frequently, but we have shown that this

risk factor is very important only when associated with childhood respiratory trouble (16). With the exception of the suburban zone, not many subjects reported exposure to dust or chemicals and fumes at work or to stove or fuels different from natural gas at home, especially in the Po Delta. We have previously shown that the effects of these risk factors on symptoms are modest (17,20) and cannot explain differences in magnitude found between the rural and the urban zones.

Prevalence rates of medical respiratory diagnoses and differences among the four zones were less than those of the symptoms. On the one hand, this suggests that we have really studied general population samples with few diseased people. On the other hand, it indicates the higher sensitivity of the standardized CNR questionnaire (interviewer/administered) for detecting adverse health effects of air pollution, as well as variability of diagnostic habits of family practitioners. If we look at ratios of the medical diagnosis of chronic bronchitis to chronic phlegm [the symptom that should be the criterion for making the diagnosis according to the CIBA Guest symposium (25)], the ratios are 0.2 in Po Delta, 0.4 in Cascina, 0.8 in Pisa-SE, 0.4 in Pisa-SW. It is noteworthy that an international study recently has shown the consistent use of this old standardized label (chronic bronchitis) among respiratory physicians (25). Thus, it seems that, with the exception of Pisa-SE, doctors underestimated the diagnosis of chronic bronchitis in relation to the presence of chronic phlegm, whereas they seemed more reliable in dealing with asthma—attacks of shortness of breath with wheeze (the ratios were 1, 0.9, 1.3, and 0.6, respectively).

In conclusion, our preliminary results indicate an urban factor in Italy in the mid-1980s. They suggest also the possible importance of the automobile exhaust exposure in promoting the occurrence of respiratory symptoms. The follow-up studies we are performing in both areas, including lung function, bronchial

responsiveness, and atopy measurements, will help us clarify the role of the different sources of air pollution in Italy in the 1990s.

The authors thank T. Sapigni (University of Ferrara) and the Scientific Committee of the Porto Tolle Power Plant, who made it possible to plan and implement the study: R. Polato, M. Saetta, R. Zambon (University of Padova); P. Fazzi, R. Prediletto, N. Piovacari, F. Di Pede (University of Pisa); G. Carli and the nurses of USL No. 31 (G. Gambato, D. Smorgon, S. Cavazzin, A. Pavan, M. Zambello, S. Zago), USL No. 33 (L. Mari) and USL No. 12 (B. Belli, G. Lazzeri, A. Cavicchi, R. Balzani, O. Bonci, M. L. Geri) for the data collection; and C. J. Holberg (University of Arizona) for the help in English editing. The writers thank also the hundreds of residents of the Delta del Po and Pisa areas who participated in the study. G. Viegi is recipient of an Italian Research Council (CNR) fellowship (Bando n.203.04.12 del 1/07/88). This work was supported in part by the Italian National Research Council, Targeted Project "Prevention and Control Disease Factors-SP22," contract no. 91.00171.PF41, the Health Departments of the Veneto and Emilia Romagna regions, the Italian Electric Power Authority (ENEL), the Health Department of Toscana region (contract no. 33393/724 of 08-10-83).

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